BIOFORSK EMA Vol.1 Nr.24 2006

Bioforsk

www.bioforsk.no

Effects of ploughing depth on the decomposition of barley straw in organically managed soil

Reidun Pommeresche, Anne-Kristin Løes, Erling L. Meisingset and Sissel Hansen,
Bioforsk- Organic Food and Farming Division.Contact: reidun.pommeresche@bioforsk.no

Organic farmers are often advised to plough shallowly (<15 cm) in order to optimise nutrient turnover and to promote the activity of soil biota, but deeper for better control of perennial weeds. Different ploughing depths (13 vs 25 cm) had minor effects on decomposition rate of barley straw and earthworm activity in the decomposing straw when using a light tractor (2 and 4 Mg). However, different burying depths (13 vs 25 cm) of barley straw had some important effects on decomposition and earthworm activity. (Norsk sammendrag til slutt)

Field experiment

Optimising plant nutrition and controlling perennial weeds are major challenges in the production of organic cereals, especially without access to animal manure. These challenges are studied at two locations in Norway with different soil and climatic conditions from 2003-2007 in the Strategic Programme "Organic cropping systems for higher and more stable cereal yields".

The effect of different ploughing depths on decomposition of barley straw, and earthworm activity were studies in plots with spring ploughing using a light tractors (2 and 4 Mg), and deep (25 cm) vs more shallow (13-15 cm) ploughing. **Site A** (Apelsvoll, eastern Norway) is on well drained loamy soil, in inland climate with medium humidity. **Site K** (Kvithamar, middle Norway)is on poorly drained silty, clay loam, in a humid coastal climate. No animal manure or artificial fertiliser was used. Nitrogen was supplied by growing legumes in the three year crop rotation (barley or wheat undersown with white clover, oats mixed with peas, and green manure composed of red clover, vetches, rye grass and phacelia). All crops grown every year.

Litterbag study

Nylon litter-bags (mesh size 5 mm) with chopped dry spring barley straw were buried at two depths (13 and 25 cm) in plots with shallow (13 cm) and deep (25 cm) ploughing in spring 2004 (Fig 1).

Figure 1. Litterbags sampled at 5 dates from the oats mixed with peas plot in the crop rotation.

The barley straw had lain over wintered on the field (to reflect spring ploughing) and was low in nutrient content (1.4 % N of DM at site A and 0.6 % at site K) and high in slowly decomposable structures (cell walls; 82% of DM at site A and 86 %

at site K). The litter-bags were buried in soil under oats with peas.
From May to October 2004, litterbags were sampled at five dates and the amount of straw and numbers of earthworm casts (excrement heaps) in the litterbags were recorded.

Straw decomposition and earthworm activity

The burying depth of the litter (13 vs. 25 cm) affected the decomposition rate of barley straw more than different ploughing depths (13 cm vs 25 cm) at the study sites.

At both locations there was a significant reduction in straw weight (on average 36% (A) and 46% (K) of initial DM) and an increase in numbers of earthworm casts in the litterbags throughout the season. No significant effects of ploughing depths were found on either of these characteristics.
The decomposition rate of straw at different burying depth varied between the two sites. At site A with loamy soil, the decomposition of straw was fastest in the deeply placed litterbags, at both ploughing depths (Fig.2).

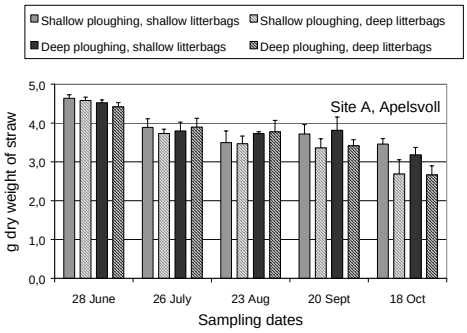

Figure 2. Straw left in the litterbags at different soil and ploughing depths, at different sampling dates (N=6) at site A. The initial dry weight of straw in each litterbag was 5 g, and the bags were all buried on 25 May 2004. The error bars represent +1 standard error.

At site K with clay soil, the decomposition was fastest in the shallowly placed litterbags in the shallow ploughed soil (Fig 3).

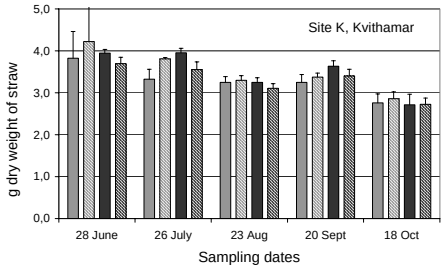

Figure 3. Straw left in the litterbags at different soil and ploughing depths, at different sampling dates (N=6) at site K. The initial dry weight of straw in each litterbag was 5 g, and the bags were all buried on 25 May 2004. Legend see fig 2.

This demonstrate the large effect of soil type on decomposition of organic material.

More earthworm activity at 15 cm

At both sites there was a tendency of more earthworm casts in the shallow litterbags, independent of ploughing depths. In general more earthworm casts were found in the loamy soil (Site A, Fig 4) than in the clay soil (Site K, Fig 5).

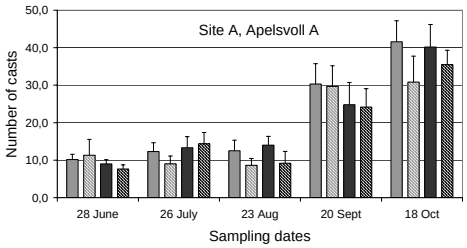

Figure 4. Earthworms casts in the litterbags at different soil and ploughing depths, at different sampling dates (N=6) at site A. Legend see fig 2.

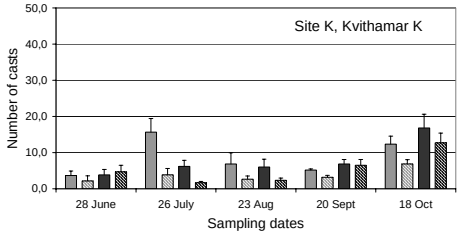

Figure 5. Earthworm casts in the litterbags at different soil and ploughing depths, at different sampling dates (N=6) at site K. Legend see fig 2.

Very few earthworms were found in the litterbags. But increasing amounts of casts from earthworms throughout the period in the litterbags, indicating earthworm activity. Three different sizes of casts were found in the litterbags (3-5mm, 5-10mm and >10mm), indicating activity of adult large worms like night crawler and field worms. To connect the sizes of the casts exactly with certain species is difficult. Large worms produce large casts, and small worms produce small cast, mostly independent of species (Fig 6).

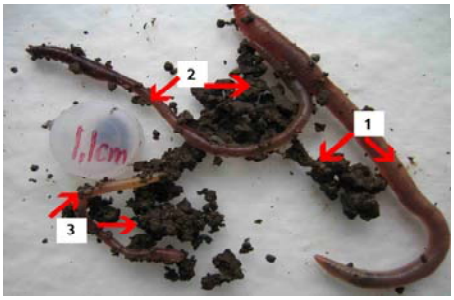

Figure 6. Large earthworms produce large casts (arrow 1, field worm ;*Aporrectodea caliginosa*), smaller once produce smaller casts arrows 2 (young red worm; *Lumbricus rubellus*) and arrow 3 (young field worm). It is difficult to connect casts directly to species.

Figures 7 and 8 show the content of one litterbag after one month in the soil (fig 7) and one after 5 months in the soil (fig 8)from site A. Large differences in the distribution of amounts of casts and the structure of the straw is visible.

Figure 7 and 8.Example of content in litterbags after one month in the soil (fig 7) and after 5 months in the soil (fig 8). After one month a few casts, one earthworm, and much straw are visible. After 5 months all the "crumbles" in the upper parts are earthworm casts. The small white labels, represent 10x10 mm squares. Less amount of and more decomposed straw are found after 5 months.

Conclusions

From our results we suggest that slowly decomposable organic matter, such as leached barley straw, may be incorporated deeply by ploughing in organic cereal production systems, in order to regulate perennial weeds. In soils with good structure and porosity, the decomposition rate of straw can even be larger with deep ploughing. In dense, clayey soils it is important to be very accurate in ploughing time in order to secure that the ploughing is in fact loosening the soil. Otherwise, lack of oxygen and low decomposition of straw is likely to be the results.

Figure 9. The field worm (*Aporrectodea caliginosa*) was found in the litterbags and are the most common earthworm in Norwegian agricultural soils. (In Norwegian grå meitemark)

Norsk sammendrag

Effekter av ulike pløyedyp (13 og 25 cm), pløyd med lett traktor (2 og 4 tonn), på omdanning av halm og på meitemarkaktivitet ble undersøkt i et strøposeforsøk i to økologiske vekstskifter med korn i Norge, på Kvithamar og Apelsvoll.

Langsomt omsettelig organisk materiale, slik som utvasket overvintret halm, kan innarbeides dypt (25 cm) ved pløying, for bedre å holde kontrollen på flerårig ugras. I jord med god struktur og porøsitet, kan omdanningshastigheten til og med være raskere ved dyp pløying, pga uttørking nær overflaten. I tett, leirholdig jord er det viktig å pløye på rett tidspunkt slik at pløyings virkelig løsner jorda. Ellers vil oksygenmangel og sein omdanning bli resultatet at dyp pløying.

Det var mer meitemark aktivitet (mer ekskrementer) i støposer ved 13 cm dyp enn ved 25 cm, uavhengig av pløyedyp. Dette støttes av at flest meitemark oppholder seg rundt planterøttene og i de øverste 20 cm av jorda.

Fagredaktør denne utgaven:
Forskningssjef Atle Wibe, Bioforsk Økologisk

Ansvarlig redaktør: Forskningsdirektør
Nils Vagstad
ISBN 82-17-00061-1
ISBN 978-82-17-00061-7

www.bioforsk.no